

# Estimated Number of Interactions

**Abstract:** The total number of neutrino interactions in the emulsion is estimated using the Monte Carlo with neutrino production estimates.

## Analysis

The Monte Carlo is used for three main functions in this analysis:

1. Generate  $\nu$ s in the dump
2. Propagate  $\nu$ s to the emulsion target
3. Assign a weight  $\propto$  production kinematics
4. Assign a weight  $\propto$  interaction probability

The separation of production weight and interaction weight is necessary here. As a reminder, the number of interactions is given as:

$$N_{\text{int}} = \frac{N_{\nu} \sigma N_{\text{nucl}}}{\text{Area}} = \left( \frac{N_{\nu}}{\text{pot}} \right) \left( \frac{1}{\text{Area}} \right) (\sigma^{\text{const}}) \left( \frac{m_{\text{tgt}}}{m_{\text{nucl}}} \right) \sum E_i \cdot K(E_i) \cdot T_i \cdot t_i$$

where  $\sigma^{\text{const}}$  is the energy-independent part of the neutrino-nucleon cross section,  $m_{\text{tgt}}$  is the emulsion target mass (e.g. the *pot*-weighted average),  $m_{\text{nucl}}$  the nucleon mass,  $E$  neutrino energy,  $K$  additional kinematic suppression ( $\tau$  only),  $T$  the binary (0 or 1) for  $\nu$  in the target and  $t$  the binary for the trigger.

Inserting numbers for the constant part yields

$$F_e = (5.88 \times 10^{-4}) (1.57 \times 10^{17}) \left( \frac{1}{2400 \text{ cm}^2} \right) (0.505 \times 10^{-38}) \left( \frac{260 \text{ kg}}{1.66 \times 10^{-27} \text{ kg}} \right)$$

This gives 68.7 for electron-neutrino interactions. The same number will be used for muon-neutrinos, and the value for tau-neutrino interactions is 10.6. The values for number of neutrinos created *per pot* are from Emily's thesis.

The part in the summation in the first equation is evaluated as one number for each flavor.

Flavor	$N_{\nu}/\text{pot}$	$\Sigma E K T t$	$F_j$	$\Pi$
$e$	$5.88 \times 10^{-4}$	4.47	68.7	307
$\mu$	$5.88 \times 10^{-4}$	7.67*	68.7	527
$\tau$	$9.08 \times 10^{-5}$	2.70	10.6	29

The total number of triggered interactions is estimated to be 863. The total number of interactions ( $t \equiv 1$ ) is 931. This may be low because to estimate the number of located events, we need to multiply by electronic, scan and location efficiencies. This is typically  $0.68 \times 0.67 = 0.46$ . Thus, our estimated number of located events is  $0.46 \times 863 = 397$ .